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Severe acute respiratory syndrome (SARS)

Report by the Secretariat

EPIDEMIOLOGY AND NATURAL HISTORY

1. On 5 July 2003, WHO announced that the last known chain of human-to-human transmission of the SARS coronavirus had been broken, bringing to an end the initial outbreak of a severe new respiratory disease that began in mid-November 2002 in southern China and spread internationally in late February 2003.
2. The most severely affected countries were China (including Hong Kong Special Administrative Region of China, and Taiwan, China), Canada, Singapore, and Viet Nam, all of which experienced outbreaks before the issue of global alerts by WHO on 12 and 15 March 2003. According to data compiled in August 2003, altogether 8422 cases occurred in 29 countries; in the four aforementioned countries 908 cases were fatal, with only eight deaths occurring in the additional 25 countries where cases were reported. The heightened vigilance, awareness of control measures, and preparedness that followed the global alerts are thought to have contributed to the prevention of further significant outbreaks.
3. Retrospective studies of patient records, by epidemiologists from China and the WHO Global Outbreak Alert and Response Network, indicate that the first chain of transmission began on 16 November 2002 in the southern Chinese province of Guangdong. From that date through mid-January 2003, small independent clusters of cases were identified in seven provincial municipalities. No link among these initial clusters of cases has so far been identified, adding weight to theories that the SARS virus jumped to human beings from an animal species or other environmental reservoir found in southern China.
4. Early reports suggested some link between cases and contact with wild animals captured or bred and marketed for human consumption. Recent studies have detected a virus almost identical to the SARS coronavirus in two animal species, the masked palm civet (*Paguma larvata*) and the raccoon dog (*Nyctereutes procyonoides*). However, much more research is needed before conclusions can be reached about an animal reservoir of the virus, the role of interspecies transmission in the origins of SARS, and the risk of repeated introduction of the virus from animals to human beings.
5. Exposure to infected respiratory droplets during close person-to-person contact and to infected fomites were the principal modes of transmission at all outbreak sites. In health-care settings, certain treatments, such as use of nebulizers, and procedures, such as intubation, contributed to the

amplification of transmission, increasing the risk of nosocomial transmission in sophisticated hospitals. Failure to recognize atypical cases, in which symptoms were often masked by underlying disease, and transfer between institutions of patients during the incubation period were other factors that amplified or reignited outbreaks.

6. In Hong Kong, an outbreak, starting in late March 2003, among residents of a single housing estate, resulting in 329 cases, with 42 deaths, has now been linked to contaminated sewage droplets and faulty bathroom drains, although other hypotheses have been proposed. Investigations of a Hong Kong hotel, where contact with an infected guest on a single floor resulted in at least 16 cases and seeded international spread, suggest that transmission followed exposure to a concentrated source of virus in the corridor.

7. SARS has many unusual clinical features, and its pathology is not yet fully understood. Children experience a mild form of disease with extremely low death rate. Mortality rates are highest in the elderly and people with underlying chronic disease. Disease in such patients frequently has an atypical presentation, further complicating diagnosis. Patients with SARS, unlike most other respiratory diseases, are most infectious at around day 10 of illness. At this point, and for unknown reasons, some patients spontaneously recover, whereas others rapidly deteriorate to severe respiratory illness, often requiring ventilatory support. Destruction of lung tissue is thought to result from an over-exuberant immune response rather than from the direct effects of viral replication. Also distinctive for a respiratory disease is shedding of the SARS coronavirus not only in respiratory secretions, but also in faeces and other bodily fluids.

IMPACT AND SIGNIFICANCE

8. The considerable economic impact of SARS illustrates the importance that a severe new disease can assume in closely interdependent and highly mobile global communities. Efforts to calculate the economic costs continue. Published estimates, largely based on the costs of cancelled travel and decreased investment in Asia, range from US\$ 30 000 million to US\$ 140 000 million. In most of the severely affected areas, service industries and airlines suffered the greatest losses.

9. SARS caused considerable social disruption and public anxiety, even in areas well beyond the outbreak sites. Hospitals, schools and some borders were closed. Thousands of persons were placed in voluntary or supervised quarantine. Avoidance of travel to certain areas was disproportionate to the risk, as was the widespread wearing of surgical masks. Patients and ethnic groups encountered discrimination. The psychosocial impact of SARS on health-care workers, affected individuals, their families and the broader community has not yet been fully evaluated. However, public awareness about SARS had benefits in terms of persuading the general public to check frequently for fever and prompt reporting of symptoms, which greatly reduced the time between onset of symptoms and isolation of patients, thus diminishing opportunities for further exposures.

10. The significance of SARS as a public health threat is considerable. All new infectious diseases are poorly understood (by definition) as they emerge and are often associated with high mortality rates. SARS was no exception, and proved to be an especially difficult disease to diagnose and treat. Many new diseases have features that limit their potential for international spread. Some never establish efficient person-to-person transmission. Others depend on the presence of a mosquito or other vector as part of the transmission cycle. Still others remain closely tied to a specific geographical region or ecosystem. For some, patients are visibly too ill to travel during the most infectious period.

11. In contrast, SARS passed readily from person to person, required no vector, had no particular geographical affinity, mimicked the symptoms of many other diseases, took its heaviest toll on hospital staff, killed around 11% of those infected, and spread internationally with alarming ease. The fact that SARS was contained less than four months after the first global alert, despite the absence of a vaccine, effective treatment or reliable point-of-care diagnostic test, is a triumph for public health and a tribute to the power of political commitment. It is also evidence of the willingness of the international community to form a united front against a shared threat, and proof of the results.

12. SARS stimulated an emergency response, and a level of media attention, on a scale that may have changed public and political perceptions of the risks associated with emerging and epidemic-prone diseases. Reports in scientific publications and the media and from governmental agencies in several countries generally agree that SARS raised the profile of public health to new heights by demonstrating the severity of adverse effects that a health problem can have on economies, social stability and political careers.

13. The fact that SARS was successfully contained using classical public health measures – case detection, isolation, infection control and contact tracing – provides encouragement for the many other health initiatives that have set ambitious goals despite the absence of sophisticated tools, such as vaccines and curative drugs. In terms of population screening for the early detection of SARS, the use of a tool as simple as the thermometer, supported by mass public education and information campaigns, was decisive. However, these control measures were extremely resource-intensive and socially disruptive, sometimes halting other important public health campaigns, including those for childhood immunization and the control of HIV/AIDS and tuberculosis.

14. Successful containment of SARS was possible, in part, because of good fortune, which may not be repeated when the next new disease inevitably emerges. All the main outbreaks occurred in areas with well-developed health systems. Had SARS become established in areas with weak health infrastructure, it is unlikely that global containment could have been achieved so rapidly, if at all. Many developing countries lack the capacity to cope with a disease that puts such demands on health systems, characterized by high infection rates among health care staff, the need for highly specialized protective equipment and isolation facilities, the long period of intensive care for many patients, and resource-intensive and disruptive control measures. These concerns further underscore the need to strengthen the capacity for outbreak detection and response in all countries, and WHO is coordinating several initiatives with this objective.

THE ROLE OF TRAVEL RECOMMENDATIONS

15. In coordinating the international response to SARS, WHO's overriding objective was to prevent SARS from becoming established as an endemic disease, with sealing off opportunities for further international spread a key strategy. As SARS spread along the routes of international air travel, travel-related recommendations were an important component of the global containment strategy.

16. Following an analysis of data on in-flight transmission of SARS (27 cases were linked to exposure on five flights), WHO issued on 27 March 2003 recommendations for the screening of airline passengers on departure from outbreak sites. No confirmed case associated with in-flight exposure was reported to WHO after that date.

17. On 2 April, WHO issued the first of several recommendations that travellers should consider postponing all but essential travel to designated areas where the risk of exposure to SARS was

considered high. Such recommendations were based on a set of epidemiological criteria that included the magnitude and dynamics of the outbreak, evidence of chains of transmission outside confined settings, such as the health care environment, and evidence that SARS was being exported to other countries.

18. Recommendations concerning travel were ended when epidemiological criteria indicating a low risk to travellers were met. That goal in itself became a motivation for governments and populations to collaborate in bringing the outbreaks under control. Many countries also set a second goal of removal from the list of areas with recent local transmission. The determination to attain this objective may have contributed to the speed with which the cycle of human-to-human transmission was broken globally.

POST-OUTBREAK RECOMMENDATIONS AND ACTIVITIES

19. WHO has posted guidelines for alert, verification, and public health management of SARS during the post-outbreak period on its web site. The guidance includes advice on risk assessment, a definition of what constitutes a SARS alert, clinical and laboratory case definitions, and recommended public health management of a SARS alert. It also includes recommendations for surveillance that are specific to three levels of risk that SARS might recur in a given geographical area, and underscores the need for continued vigilance.

20. The existence of preparedness plans and the prompt and open reporting of suspected cases build public confidence, which may help in future to allay some of the anxiety that accompanied the emergence of SARS and contributed to its considerable impact on economies and societies. Preparedness plans for a recurrence of SARS are in place at all the main outbreak sites and, in some cases, have been put to the test. During the post-outbreak period, the reporting and investigation of several suspected cases of SARS indicate that vigilance remains high. Of these suspected cases only one has been laboratory confirmed. Rapid detection and proper management of that case, which has been linked to a laboratory accident, prevented further transmission, thereby validating the preparedness plans. However, the case also highlights the significant risk of a recurrence of SARS arising from accidents in the many laboratories conducting research on the virus or holding patients' samples.

21. WHO is continuing to build on the international networks of real-time collaboration that expedited understanding of SARS and identification of its causative agent early in the outbreak. Regular teleconferences are held with epidemiologists, clinicians and laboratory experts, and a new

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